Chapter 7

7

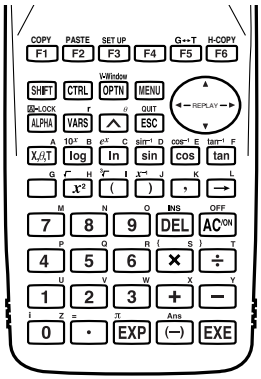
Computer Algebra System and Tutorial Modes

7-1 Using the CAS (Computer Algebra System) Mode
7-2 Algebra Mode
7-3 Tutorial Mode
7-4 Algebra System Precautions

7-1 Using the CAS (Computer Algebra System) Mode

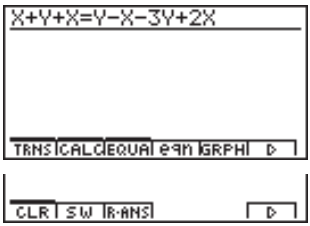
On the Main Menu, select the **CAS** icon to enter the CAS Mode.

The following table shows the keys that can be used in the CAS Mode.

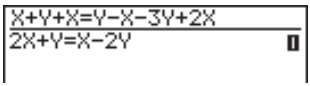


■ Inputting and Displaying Data

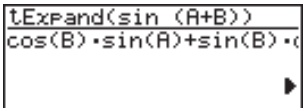
Input in the Algebra Mode is performed in the upper part of the display, which is called the "input area." You can input commands and expressions at the current cursor location.



Calculation results appear in the lower part of the display, which is called the "output area." When a calculation produces an equation or inequality, the lower part of the display is divided between a "natural result display area" for the result, and a "formula number area" for the formula number as shown below.



If all the result does not fit on the display, use the cursor keys to scroll it.



■ Performing an Algebra Mode Operation

There are two methods that you can use for input in the Algebra Mode.

- Function menu command input
- Manual formula and parameter input

■ Menu Command Input

Press a function menu key to display the menu of functions for the type of operation you are trying to perform.

- **TRNS** ... {formula transformation menu}
- **CALC** ... {formula calculation menu}
- **EQUA** ... {equation, inequality menu}
- **eqn** ... {calls up an equation stored in Equation Memory in accordance with a specified input value}
- **CLR** ... {variable/formula delete menu}

For details on commands and their formats, see the “Algebra Command Reference” on page 7-1-7.

■ Manual Formula and Parameter Input

You can use the function menus, [OPTN] key, and [VARS] key in combination to input formulas and parameters as described below.

- [F3](EQUA)[1](INEQUA)
  - {**>**}/{**<**}/{**≥**}/{**≤**} ... {inequality}
- [OPTN] key
  - {∞}/{**Abs**}/{x**!**}/{**sign**} ... {infinity}/{absolute value}/{factorial}/{signum function*1}
  - {**HYP**} ... {hyperbolic}/{inverse hyperbolic} functions
    - **{sinh}/{cosh}/{tanh}/{sinh^{-1}}/{cosh^{-1}}/{tanh^{-1}}**
- [VARS] key
  - {**Y**}/{r}/{**X**t}/{**Y**t}/{**X**} ... input of graph memory {Y}/{r}/{Xt}/{Yt}/{X}

■ Formula Memory

The CAS Mode has 28 formula variables. Variable names are the letters A through Z, plus r, and θ. CAS Mode formula variables are independent of standard value variables.*2

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Example **To assign a formula that differentiates sin(X) at X (cos(X)) to variable A**

[F2](CALC)[1](diff)[sin][X,θ,T][,]
[X,θ,T][)]→[ALPHA][X,θ,T](A)[EXE]

```
diff(sin X,X)→A
cos(X)
```

*1 $signum\ (A)$ {
- 1 (real number, $A > 0$)
- −1 (real number, $A < 0$)
- $\frac{A}{|A|}$ (A= imaginary number)
- Undefined ($A = 0$)

*2 Use the approx command before inputting to register a value to a general variable.
Example: approx 1 → A

■ Function Memory and Graph Memory

Function memory lets you store functions for later recall when you need them.

With graph memory, you can store graphs in memory. Press the [VARS] key and then input the name of the graph.

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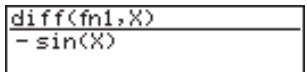
Example **To differentiate $f_1 = \cos(X)$, which is assigned to function memory f_1, at X**

[F2] (CALC) [1] (diff) [OPTN] [F6] (FMEM)
[3] (fn) [1] [,] [X,θ,T] [)] [EXE]



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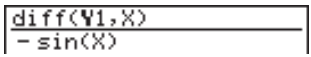
Example **To differentiate Y1 = cos(X), which is assigned to graph memory Y1, at X**

[F2] (CALC) [1] (diff)
[VARS] [F1] (Y) [1] [,] [X,θ,T] [)] [EXE]



■ Eqn Memory

When a calculation result is an equation or inequality, its formula number is displayed in the formula number area, and the equation is stored in Eqn memory.*1 Stored equations can be recalled with the eqn command, rclEqn command or rclAllEqn command.

*1 Up to 99 formulas can be stored in Eqn memory.
The error message "Memory ERROR" when you try to store an equation when there are already 99 equations in Eqn memory. When this happens, execute the ALLEQU (Delete All Equations) from the CLR menu.

■ Answer (Ans) Memory and Continuous Calculation

Answer (Ans) memory and continuous calculation can be used just as with standard calculations. In the Algebra Mode, you can even store formulas in Ans memory.

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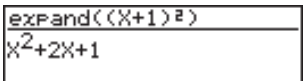
Example **To expand $(X+1)^2$ and add the result to 2X**

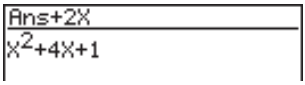
F1 (TRNS) 1 (expand)

(X,θ,T + 1) x^2) EXE



Continuing:

+ 2 X,θ,T EXE



■ Replay Contents

Replay memory can be used in the input area. After a calculation is complete, pressing ◄ or ► in the input area recalls the formula of the last calculation performed. After a calculation or after pressing AC, you can press ▲ or ▼ to recall previous formulas.

■ Moving the Cursor Between Display Areas

When ◄ ► ▲ ▼ indicates a calculation result that does not fit on the display, the cursor keys perform output area scrolling. To use the Replay Function from this condition, press F6 (▷) F2 (SW). ◄ ► ▲ ▼ change to a dotted line display to indicate that cursor key operations control the input area.

Pressing F2 (SW) again moves the cursor back to the output area.

Pressing F6 (▷) F1 (CLR) 3 (ALLEQU) deletes Eqn memory, Ans memory, and Replay memory contents.

You can input up to 255 bytes of data into the input area.

SET UP Items

- **Angle** ... Unit of angular measurement specification
  - {**Deg**}/{**Rad**} ... {degrees}/{radians}
- **Answer Type** ... Result range specification
  - {**Real**}/{**Cplx**} ... {real number}/{complex number}
- **Display** ... Display format specification (for approx only)
  - {**Fix**}/{**Sci**}/{**Norm**} ... {number of decimal places}/{number of significant digits}/{normal display format}

■ Graph Function

Pressing F5(GRPH) displays the graph formula screen. You can execute F1(SEL) and F2(DEL) from this screen. Pressing F6(DRAW) graphs the SET condition expressions.

■ RECALL ANS Function

Pressing F6(▷)F3(R•ANS) recalls Ans Memory contents.

Algebra Command Reference

The following are the abbreviations used in this section.

- **Exp** ... Expression (value, formula, variable, etc.)
- **Eq** ... Equation
- **Ineq** ... Inequality

Anything enclosed within square brackets can be omitted.

• expand

Function: Expands an expression.

Syntax: expand ({Exp/Eq/Ineq} [ )]

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Example **To expand $(X+2)^2$**

[F1] (TRNS) [1] (expand) [(] [X,θ,T] [+] [2] [)] [x^2] [EXE] **$X^2 + 4X + 4$**

• rFactor (rFctor)

Function: Factors an expression up to its root.

Syntax: rFactor ({Exp/Eq/Ineq} [ )]

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Example **To factor the $X^2 - 3$**

[F1] (TRNS) [2] (rFctor) [X,θ,T] [x^2] [−] [3] [EXE] **$(X - \sqrt{3})(X + \sqrt{3})$**

• factor

Function: Factors an expression.

Syntax: factor ({Exp/Eq/Ineq} [ )]

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Example **To factor $X^2 - 4X + 4$**

[F1] (TRNS) [3] (factor) [X,θ,T] [x^2] [−] [4] [X,θ,T] [+] [4] [EXE] **$(X - 2)^2$**

• solve

Function: Solves an equation.

Syntax: solve(Exp [,variable] [ )]

solve({Exp-1,..., Exp-n}, {variable-1,...,variable-n} [ )]

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Example **To solve AX + B = 0 for X**

F1 (TRNS) 4 (solve) ALPHA X,θ,T (A) X,θ,T + ALPHA log (B) SHIFT • (=) 0 EXE

$$X = \frac{-B}{A}$$

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Example **To solve simultaneous linear equation 3X + 4Y = 5, 2X – 3Y = – 8**

F1 (TRNS) 4 (solve) SHIFT × ({)

3 ALPHA + (X) + 4 ALPHA − (Y) SHIFT • (=) 5 ,

2 ALPHA + (X) − 3 ALPHA − (Y) SHIFT • (=) (−) 8

SHIFT ÷ (}) , SHIFT × ({) ALPHA + (X) ,

ALPHA − (Y) SHIFT ÷ (}) EXE

X = – 1

Y = 2

• X is the default when no variable is specified.

• tExpand (tExpnd)

Function: Employs the addition theorem to expand a trigonometric function.

Syntax: tExpand(Exp [ )]

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Example **To employ the addition theorem to expand sin(A+B)**

F1 (TRNS) 5 (TRIG) 1 (tExpnd)

sin (ALPHA X,θ,T (A) + ALPHA log (B) EXE

cos(B) • sin(A) + sin(B) • cos(A)

• tCollect (tCollc)

Function: Employs the addition theorem to transform the product of a trigonometric function to a sum.

Syntax: tCollect(Exp [ )]

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Example **To employ the addition theorem to transform sin(A)cos(B) to trigonometric sum.**

F1 (TRNS) 5 (TRIG) 2 (tCollc)

sin ALPHA X,θ,T (A) cos ALPHA log (B) EXE

$$\frac{\sin(A+B)}{2} + \frac{\sin(A-B)}{2}$$

• trigToExp (trigToE)

Function: Transforms a trigonometric or hyperbolic function to an exponential function.

Syntax: trigToExp(Exp [ )]

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Example **To convert cos(iX) to an exponential function**

F1 (TRNS) 5 (TRIG) 3 (trigToE) cos SHIFT 0 (*i*) X,θ,T EXE

$$\frac{e^{X}+e^{-X}}{2}$$

• expToTrig (expToT)

Function: Converts an exponential function to a trigonometric or hyperbolic function.

Syntax: expToTrig(Exp [ )]

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Example **To convert e^{iX} to a trigonometric function**

F1 (TRNS) 5 (TRIG) 4 (expToT)

SHIFT ln (e^{x}) (SHIFT 0 (*i*) X,θ,T EXE

cos(X) + sin(X) • i

• simplify (smplfy)

Function: Simplifies an expression.

Syntax: simplify({Exp/Eq/Ineq} [ )]

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Example **To simplify 2X + 3Y – X + 3 = Y + X – 3Y + 3 – X**

F1 (TRNS) 6 (smplfy) 2 ALPHA + (X) + 3 ALPHA − (Y)
− ALPHA + (X) + 3 SHIFT • (=) ALPHA − (Y)
+ ALPHA + (X) − 3 ALPHA − (Y) + 3 −
ALPHA + (X) EXE

X + 3Y + 3 = –2Y + 3

• combine (combin)

Function: Reduces a fraction.

Syntax: combine({Exp/Eq/Ineq} [ )]

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Example **To reduce the fraction (X + 1)/(X + 2) + X (X + 3)**

F1 (TRNS) 7 (combin) (X,θ,T + 1) ÷
(X,θ,T + 2) + X,θ,T (X,θ,T + 3 EXE

$$\frac{X^3 + 5X^2 + 7X + 1}{X + 2}$$

• collect (collct)

Function: Rearranges an expression, focusing on a particular variable.

Syntax: collect({Exp/Eq/Ineq} [,Exp-1/, variable] [ )]

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Example **To rearrange $X^2 + AX + BX$, focusing on the variable X**

F1 (TRNS) 8 (collct) X,θ,T x^3 + ALPHA X,θ,T (A) X,θ,T +
ALPHA log (B) X,θ,T EXE

$X^2 + (A + B)X$

• X is the default when nothing is specified for [,Exp-1/, variable].

• substitute (sbstit)

Function: Assigns an expression to a variable.

Syntax: substitute({Exp/Eq/Ineq}, variable=expression [,..., variable=expression] [ )]

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Example **To assign 5 to X in 2X – 1**

F1 (TRNS) 9 (sbstit) 2 X,θ,T − 1 ,
X,θ,T SHIFT • (=) 5 EXE

9

• cExpand (cExpnd)

Function: Expands xth root of imaginary number.

Syntax: cExpand(Exp [ )]

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Example **To expand $\sqrt{2}i$**

F1 (TRNS) X,θ,T (cExpnd) SHIFT x^2 ($\sqrt{\ }$) 2 SHIFT 0 (i) EXE

1 + i

• **approx**

Function: Produces a numerical approximation for an expression.

Syntax: approx Exp

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Example **To obtain a numerical value for $\sqrt{2}$**

F1 (TRNS) log (approx) SHIFT x^2 ($\sqrt{\ }$) 2 EXE **1.414213562**

■ About approx

Using approx affects the number of digits used to display a calculation result and the way calculations that include variables are performed in the CAS Mode.

With normal calculations (when approx is not used) in the CAS Mode, calculation results are displayed in full, without using exponents. When you use approx in the CAS Mode, however, results are displayed using the exponential format range specified by the Display item of the SET UP screen.

This means approx displays results in the CAS Mode the same way they are displayed in the RUN•MAT Mode.

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Example 9^{20}

Normal: 9 ^ 2 0 EXE **12157665459056928801**

approx: F1 (TRNS) log (approx) 9 ^ 2 0 EXE **1. 215766546E+19 (Display: Norm1)**

If you use approx to execute an expression that contains a variable, the value assigned to the variable in general variable memory (variable memory recalled using RUN•MAT) is used for the calculation.

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Example **5A + 3, when A = 1.3**

Normal: 5 ALPHA X,θ,T (A) + 3 EXE **5A + 3**

approx: F1 (TRNS) log (approx) 5 ALPHA X,θ,T (A) + 3 EXE **9.5**

A Syntax ERROR occurs if a calculation is performed in front of (to the left of) the approx command.

Example: 1+approx($\sqrt{2}$) ... Syntax ERROR

• diff

Function: Differentiates an expression.

Syntax: diff(Exp [, variable, order, derivative] [ )]
diff(Exp, variable [, order, derivative] [ )]
diff(Exp, variable, order [, derivative] [ )]

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Example **To differentiate X^6 with respect to X**

F2 (CALC) 1 (diff) X,θ,T ^ 6 EXE $6X^5$

• X is the default when no variable is specified.
• 1 is the default when no order is specified.

• ∫

Function: Integrates an expression.

Syntax: ∫(Exp [, variable, integration constant] [ )]
∫(Exp, variable [, integration constant] [ )]
∫(Exp, variable, lower limit, upper limit [ )]

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Example **To integrate X^2 with respect to X**

F2 (CALC) 2 (∫) X,θ,T x^2 EXE $\frac{X^3}{3}$

• X is the default when no variable is specified.

• lim

Function: Determines the limits of a function expression.

Syntax: lim(Exp, variable, point [, direction] [ )]

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Example **To determine the limits of sin(X)/X when X = 0**

F2 (CALC) 3 (lim) sin X,θ,T ÷ X,θ,T , X,θ,T , 0 EXE **1**

• Direction can be positive (from right) or negative (from left).

• Σ

Function: Calculates a sum.

Syntax: Σ(Exp, variable, start value, end value [ )]

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Example **To calculate the sum as the value of X in X^2 changes from X = 1 through X = 10**

F2 (CALC) 4 (Σ) X,θ,T x^2) X,θ,T) 1) 1 0 EXE **385**

• Π

Function: Calculates a product.

Syntax: Π(Exp, variable, start value, end value [ )]

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Example **To calculate the product as the value of X in X^2 changes from X = 1 through X = 5**

F2 (CALC) 5 (Π) X,θ,T x^2) X,θ,T) 1) 5 EXE **14400**

• taylor

Function: Finds a Taylor polynomial.

Syntax: taylor(Exp, variable, order [, center point] [ )]

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Example **To find a 5th order Taylor polynomial for sin(X) with respect to X = 0**

F2 (CALC) 6 (taylor) sin X,θ,T) X,θ,T) 5) 0 EXE $\frac{X^5}{120} - \frac{X^3}{6} + X$

• The default center point is zero.

• arcLen

Function: Returns the arc length.

Syntax: arcLen(Exp, variable, start value, end value [ )]

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Example **To determine the arc length for X^2 from X = 0 to X = 1**

F2 (CALC) 7 (arcLen)
X,θ,T x^2) X,θ,T) 0) 1 EXE $\frac{\ln(4\sqrt{5}+8)}{4} - \frac{\ln(2)}{2} + \frac{\sqrt{5}}{2}$

• tanLine (tanLin)

Function: Returns the expression for a tangent line.

Syntax: tanLine(Exp, variable, variable value at point of tangency [ )]

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Example **To determine the expression for a line tangent with X^3 when X = 2**

[F2](CALC)[8](tanLin)[X,θ,T][^][3][,][X,θ,T][,][2][EXE] **12X – 16**

• denominator (den)

Function: Extracts the denominator of a fraction.

Syntax: denominator(Exp [ )]

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Example **To extract the denominator of the fraction (X + 2)/(Y – 1)**

[F2](CALC)[9](EXTRCT)[1](den)

[(][ALPHA][+](X)[+][2][)][÷][(][ALPHA][−](Y)[−][1][EXE] **Y – 1**

• numerator (num)

Function: Extracts the numerator of a fraction.

Syntax: numerator(Exp [ )]

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Example **To extract the numerator of the fraction (X + 2)/(Y – 1)**

[F2](CALC)[9](EXTRCT)[2](num)

[(][ALPHA][+](X)[+][2][)][÷][(][ALPHA][−](Y)[−][1][EXE] **X + 2**

• gcd

Function: Returns the greatest common denominator.

Syntax: gcd(Exp, Exp [ )]

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Example **To determine the greatest common denominator of X + 1 and X^2 – 3X – 4**

[F2](CALC)[X,θ,T](gcd)[X,θ,T][+][1][,][X,θ,T][x²][−]

[3][X,θ,T][−][4][EXE] **X + 1**

• rclEqn

Function: Recalls multiple eqn memory contents.

Syntax: rclEqn(memory number [, ..., memory number] [ )]

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Example **To recall the contents of equation memory 2 and equation memory 3**

[F3](EQUA)[2](rclEqn)[2][,][3][EXE] **3X – Y = 7**

3X + 6Y = 63

• The memory numbers of equations produced as the result of a recall are not updated.

• rclAllEqn (rclAll)

Function: Recall all eqn memory contents.

Syntax: rclAllEqn

• The memory numbers of equations produced as the result of a recall are not updated.

• rewrite (rewrit)

Function: Moves the right side element to the left side.

Syntax: rewrite({Eq/Ineq} [ )]

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Example **To move the right side element of $X + 3 = 5X - X^2$ to the left side**

[F3](EQUA)[4](rewrit)[X,θ,T][+][3][SHIFT][·](=)

[5][X,θ,T][−][X,θ,T][x^2][EXE] **$X^2 - 4X + 3 = 0$**

• exchange (exchng)

Function: Exchanges the right-side and left-side elements.

Syntax: exchange({Eq/Ineq} [ )]

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Example **Exchange the left-side and right-side elements of 3 > 5X – 2Y**

[F3](EQUA)[5](exchng)[3][F3](EQUA)[1](INEQUA)[1](>)

[5][ALPHA][+](X)[−][2][ALPHA][−](Y)[EXE] **5X – 2Y < 3**

• eliminate (elim)

Function: Assigns an expression to a variable.

Syntax: eliminate({Eq/Ineq} -1, variable, Eq-2 [ )]

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Example **To transform Y = 2X + 3 to X= and then substitute 2X + 3Y = 5**

F3 (EQUA) 6 (elim) 2 ALPHA + (X) + 3 ALPHA − (Y) SHIFT • (=)
5 , ALPHA + (X) , ALPHA − (Y) SHIFT • (=)
2 ALPHA + (X) + 3 EXE **4Y – 3 = 5**

• getRight (getRgt)

Function: Gets the right-side element.

Syntax: getRight({Eq/Ineq} [ )]

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Example **To extract the right side element of $Y = 2X^2 + 3X + 5$**

F3 (EQUA) 7 (getRgt) ALPHA − (Y) SHIFT • (=)
2 ALPHA + (X) x^2 + 3 ALPHA + (X) + 5 EXE **$2X^2 + 3X + 5$**

• eqn

Function: Recalls eqn memory contents.

Syntax: eqn(memory number [ )]

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Example **To add 15 to both sides of the equation 6X – 15 = X – 7, which is stored in equation memory 3**

F4 (eqn) 3) + 1 5 EXE **6X = X + 8**

• clear (clrVar)

Function: Clears the contents of specific equation (A to Z, r, θ).*1

Syntax: clear(variable [ )]
clear({variable list} [ )]

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Example **To clear the contents of variable A**

F6 (▷) F1 (CLR) 1 (clrVar) ALPHA X,θ,T (A) EXE **{ }**

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Example **To clear the contents of variables X, Y, and Z**

F6 (▷) F1 (CLR) 1 (clrVar) SHIFT × ({) ALPHA + (X) ,
ALPHA − (Y) , ALPHA 0 (Z) SHIFT ÷ (}) EXE **{ }**

• clearVarAll (VarAll)

Function: Clears the contents of all 28 variables (A to Z, r, θ).

Syntax: clearVarAll **{ }**

*1 When you start out with memories A, B, C, and D, for example, and delete memories A and B, the display shows only C,D because they are the only memories remaining.

7-2 Algebra Mode

The CAS Mode automatically provides you with the final result only. The Algebra Mode, on the other hand, lets you obtain intermediate results at a number of steps along the way.

On the Main Menu, select the **ALGEBRA** icon to enter the Algebra Mode. The screens in this mode are the same as those in the CAS Mode.

Operations in the Algebra Mode are identical to those in the CAS Mode, except for a number of limitations. Also, the following commands are available in the Algebra Mode only.

• arrange (arrang)

Function: Arranges terms in sequence of their variables.

Syntax: arrange({Exp/Eq/Ineq} [ )]

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Example **To arrange 2X + 3 – 5X + 8Y in sequence of its variables**

F1 (TRNS) 9 (arrang) 2 ALPHA + (X) + 3 −
5 ALPHA + (X) + 8 ALPHA − (Y) EXE **– 5X + 2X + 8Y + 3**

• replace (replac)

Function: Replaces a variable with the expression assigned to the corresponding expression variable.

Syntax: replace({Exp/Eq/Ineq} [ )]

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Example **To replace S in the expression 3X + 2S, when the expression 2X + 1 is assigned to S**

F1 (TRNS) X,θ,T (replac) 3 X,θ,T + 2 ALPHA × (S) EXE **3X + 2 (2X + 1)**

- **absExpand (absExp)**

  Function: Divides an expression that contains an absolute value into two expressions.

  Syntax: absExpand({Eq/Ineq} [ )]

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  Example **To strip the absolute value from | 2X – 3 | = 9**

  F3 (EQUA) 8 (absExp) OPTN F1 (Abs) (**2X – 3 = 9** **1**

  2 X,θ,T − 3) SHIFT • (=) 9 EXE **or 2X – 3 = – 9** **2**

7-3 Tutorial Mode

On the Main Menu, select the **TUTOR** icon to enter the Tutorial Mode.

■ Tutorial Mode Flow

1. Specify the expression type.
2. Define the expression.
3. Specify the solve mode.

■ Specifying the Expression Type

Entering the Tutorial Mode displays a menu of the following expression types.

- Linear Equation
- Linear Inequality
- Quadratic Equation
- Simul (Simultaneous) Equation

Use the cursor keys to highlight the expression type you want to specify, and then press [EXE].

This displays a list of formulas for the expression type you select. Move the cursor to the formula you want to use.

In the case of Linear Inequality, press [F4](TYPE) to select the inequality type.

The following shows the formulas available for each type of expression.

Linear Equation — 6 Types

- $AX = B$
- $AX + B = C$
- $A(BX + C) = D(EX + F)$
- $X + A = B$
- $AX + B = CX + D$
- $|AX + B| = C$

Linear Inequality — 6 × 4 Types

- $AX \{ > < \geqq \leqq \} B$
- $AX + B \{ > < \geqq \leqq \} C$
- $A(BX + C) \{ > < \geqq \leqq \} D(EX + F)$
- $X + A \{ > < \geqq \leqq \} B$
- $AX + B \{ > < \geqq \leqq \} CX + D$
- $|AX + B| \{ > < \geqq \leqq \} C$

Quadratic Equation — 5 Types

- $AX^2 = B$
- $AX^2 + BX + C = 0$
- $AX^2 + BX + C = DX^2 + EX + F$
- $(AX + B)^2 = C$
- $AX^2 + BX + C = D$

Simul Equation — 10 Types

- $AX + BY = C$
  $DX + EY = F$
- $AX + BY + C = 0$
  $DX + EY + F = 0$
- $AX + BY = C$
  $Y = DX + E$
- $AX + BY = C$
  $DX + EY + F = GX + HY + I$
- $AX + BY + C = DX + EY + F$
  $Y = GX + H$
- $Y = AX + B$
  $Y = CX + D$
- $AX + BY + C = DX + EY + F$
  $GX + HY + I = JX + KY + L$
- $AX + BY = C$
  $DX + EY + F = 0$
- $AX + BY + C = 0$
  $Y = DX + E$
- $AX + BY + C = 0$
  $DX + EY + F = GX + HY + I$

Pressing [F6](EXCH) reverses the left side and right side elements of the expression.

■ Defining the Expression

In this step, you specify coefficients and define the expression. You can select any of the three following methods for specifying coefficients.

- {**RAND**} ... {random generation of coefficients}
- {**INPUT**} ... {key input of coefficients}
- {**SMPL**} ... {selection of coefficients from samples}
- {**SEED**} ... {selection of a number from 1 to 99 (specification of the same number displays the same expression)}

F1 (RAND) or EXE generates random coefficients and defines the expression.

F2 (INPUT) displays the coefficient input screen. Input coefficients, pressing EXE after each. After you finish inputting all the coefficients, press F6 (EXE) to define the coefficient.

F3 (SMPL) displays a number of preset sample expressions. Highlight the one you want to use and then press EXE to define it.

Pressing F4 (SEED) displays a number selection screen. When you want to create the same problem on another calculator, specify an appropriate matching number and press EXE.

No matter what method you use, the expression you define is displayed in the output area.

You can copy an expression to the Graph Mode as a graph function*1.

- {**L•COP**}/{**R•COP**} ... copy {left side element}/{right side element} as a graph function

(Simultaneous Equation Mode*2)

- {**1•COP**}/{**2•COP**} ... copy {first}/{second} expression as a graph function

*1 In the case of an inequality, the inequality symbols are also copied.

*2 Simultaneous equations are transformed to the format Y = AX + B when copied.

■ Specifying the Solve Mode

You can select one of the following three solve modes for the displayed expression.

• {**VRFY**} ... {Verify Mode}

In this mode, you input a solution for verification of whether or not it is correct. It provides a good way to check solutions you arrive at manually.

• {**MANU**} ... {Manual Mode}

In this mode, you manually input algebra commands, transform the expression, and calculate a result.

• {**AUTO**} ... {Auto Mode}

In this mode, the solution is produced automatically, one step at a time.

■ Verify Mode

Press F4(VRFY) to enter the Verify Mode.

The expression is shown in the top line of the display. Input the solution underneath it, and then press F6(JUDG) to determine whether the solution is correct.

The verification result screen shows the left side and right side verification result (except for a linear equation).

- However, in the case where a linear equation or quadratic equation has two solutions, the left side and right side are obtained for the value where the pointer is located.
- In the case of simultaneous equations where the left side and right side of the second equation are dissimilar even though the left side and right side of the first equation match, the left side and right side of the second equation only are obtained. In other cases, the left side and right side of the first equation are obtained.

The type of solution input screen that appears is selected according to the expression type. To input a different type, press F1(TYPE) and then select the solution type you want to want to use. Available solution types depend on the mode.

• {**X = a**} ... X has one solution (X = a) (linear equation default)

• {**X = a, b**} ... X has two solutions (X = a, X = b) (quadratic equation default)

• {**X = a, Y=**} ... X and Y have one solution each (X = a, Y = b) (simultaneous equation default)

• {**X > a**} ... X { > < ≧ ≦ } a (linear inequality default)

• {**X < a, b <**} ... X < a, b < X or X ≦ a, b ≦ X

• {**a < X < b**} ... a < X< b, a ≦ X ≦ b or X = a

• {**Identi**} **(Identity)** ... identity of left side and right side

• {**Many**} **(Many Solutions)** ... many solutions

• {**No sol**} **(No Solution)** ... no solution

You can press [F4](MANU) to change to the Manual Mode or [F5](AUTO) to change to the Auto Mode.

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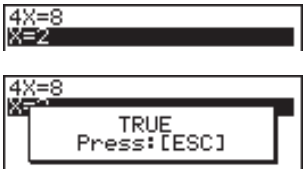
Example **To solve 4X = 8 in the Verify Mode**

(Linear Equation)(AX = B)

[F2](INPUT)[4][EXE][8][EXE][F6](EXE)

[F4](VRFY)[2][EXE]

[F6](JUDG)



■ Manual Mode

Press F5(MANU) to enter the Manual Mode.

As with the Algebra Mode, the screen is divided between an input area and a display area. This means you can select Algebra Mode commands from the function menu, transform the expression, and solve it.

Operation is the same as that in the Algebra Mode.

After you obtain a result, you can press F5(JUDG) to determine whether or not it is correct.

- {**DISP**} ... Determines whether the expression in the display area is a correct solution.
- {**Indenti**} ... identity of left side and right side
- {**Many**} ... many solutions
- {**No sol**} ... no solution

You can press F6(AUTO) to change to the Auto Mode.

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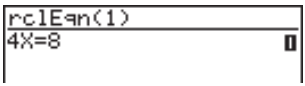
Example **Solve 4X = 8 in the Manual Mode**

(Linear Equation)(AX=B)

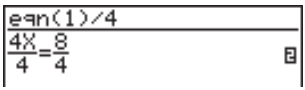
F2(INPUT) 4 EXE 8 EXE F6(EXE)

F5(MANU)



F4(eqn) 1) ÷ 4

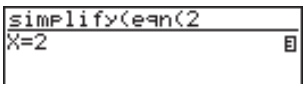
EXE



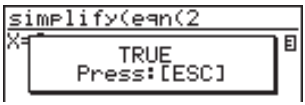
F1(TRNS) 1(smplfy)

F4(eqn) 2

EXE



F5(JUDG) 1(DISP)



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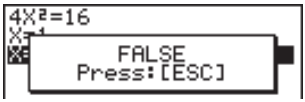
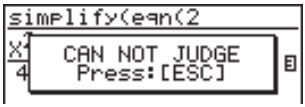
Example **$4X^2 = 16$**
True (X = 2, X = – 2)

Besides “TRUE” the messages shown below can also appear as the result of verification. “CAN NOT JUDGE” appears in the Manual Mode, while the other messages appear in both the Verify Mode and Manual Mode.





- **andConnect (andCon)**

  Function: Connects two inequalities into a single expression.

  Syntax: andConnect(Ineq-1, Ineq-2 [ )]

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  Example **To combine X > – 1 and X < 3 into a single inequality**

  F2 (EQUA) 6 (andCon) X,θ,T F2 (EQUA) 1 (INEQUA) 1 (>)
  (–) 1 , X,θ,T F2 (EQUA) 1 (INEQUA) 2 (<) 3 EXE **–1 < X < 3**

■ Auto Mode

Press [F6](AUTO) to enter the Auto Mode.

In the Simultaneous Equation Mode, you must also select SBSTIT (Substitution Method) or ADD-SU (Addition/Subtraction Method).

The Substitution Method first transforms the equation to the format Y = aX + b, and substitutes the other expression to Y.*1

The Addition/Subtraction Method multiplies both sides of the expression by the same value to isolate the coefficient X (or Y).

As with the Algebra Mode, the screen is divided between an input area and a display area.

Each press of [F6](NEXT) advances to the next step. [F6](NEXT) is not shown on the display when after the solution is obtained.

You can scroll back through the steps by pressing [F1](BACK).

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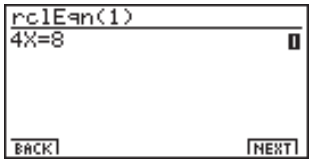
Example **To solve 4X = 8 in the Auto Mode**

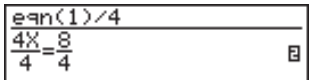
(Linear Equation)(AX = B)

[F2](INPUT) [4] [EXE] [8] [EXE] [F6](EXE)

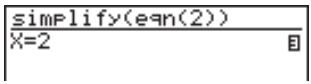
[F6](AUTO)



[F6](NEXT)



[F6](NEXT)



*1 You can press [F5](ADD SU) at any time to switch from Substitution Method to Addition / Subtraction Method.

See 7-1-6 for information about graph functions.

7-4 Algebra System Precautions

- If an algebraic operation cannot be performed for some reason, the original expression remains on the display.
- It may take considerable time to perform an algebraic operation. Failure of a result to appear immediately does not indicate malfunction of the computer.
- Any expression can be displayed in various different formats. Because of this, you should not assume that an expression is wrong just because it does not appear as you expected.
- This calculator performs integration calculations under the assumption that integrals are always positive, even when the integrals are discontinuous (due to a switch between positive and negative).

$\left[f(x) \right]$
$F(x)$: primitive function of $f(x)$

$$\int_a^b f(x)dx = F(b) - F(a)$$